

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

In re Application of: Knall *et al.*) Confirmation No.: 2700
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Serial No.: 10/689,187) Examiner: David S. Blum
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Filed: October 20, 2003) Group Art Unit: 2813
)
For: Three-Dimensional Memory Array) Docket No: SD-MA-002-1-I-a
and Method of Fabrication)

REPLY BRIEF

Appellants respectfully submit this brief in reply to the Examiner's Answer mailed December 31, 2008, pursuant to the appeal from the Examiner's final rejection mailed April 17, 2006.

STATUS OF CLAIMS

Claims 1 and 2 are pending in the application. Claims 1 and 2 stand rejected and are the subject of this appeal.

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

There are two grounds of rejection to be reviewed on appeal:

- A. Independent claim 1 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Zhang, US Patent No. 5,835,396 (“Zhang ’396”), in view of Zhang et al., US Patent No. 6,111,302 (“Zhang ’302”). Appellants assert there is no motivation to make the suggested combination.
- B. Independent claim 1 and its dependent claim 2 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Zhang ’396 in view of Mohsen et al., US Patent No. 4,881,114 (“Mohsen”). Appellants assert there is no motivation to make the suggested combination.

ARGUMENT

The Examiner's answer maintains the rejection of claim 1 under § 103(a) as obvious over Zhang '396 and Zhang '302, and the rejection of claims 1 and 2 under § 103(a) as obvious over Zhang '396 and Mohsen. Appellants respectfully disagree and request that the Board reverse the decision of the Examiner.

A. Rejection of Claim 1 Based on Zhang '396 and Zhang '302

The Examiner's Answer at 4-5 asserts that it would have been obvious to one of ordinary skill in the art to modify the amorphous silicon antifuse layer of Zhang '396 by using the silicon nitride antifuse of Zhang '302 because (1) Zhang '302 shows that silicon nitride and amorphous silicon are considered art recognized equivalents that may be used interchangeably as metal-to-metal antifuses, and (2) a person skilled in the art would appreciate that because Zhang '396 and Zhang '302 are directed toward metal-to-metal antifuses using "generally similar materials and similar structures," it would be reasonable and apparent to apply any of the specific antifuse materials in Zhang '302 to the structure of Zhang '396. The Examiner's Answer at 8 concedes that the previously asserted "switch-off" motivation was misplaced, and has withdrawn that asserted argument.

The Amended Appeal Brief clearly disproved the Examiner's assertion that Zhang '396 and '302 include metal-to-metal antifuses, and use generally similar materials and similar structures. As previously stated, Zhang '396 discloses embodiments in FIGS. 9a-9c that include low thermal resistance top and bottom conductors 502 and 503 (different from the high thermal resistance top and bottom conductors 14 and 22 of Zhang '302), and at least some other layer, either a quasi-conduction layer, a p-n diode, or a quasi-conduction layer *and* a buffer layer, all unlike the simple conductor-to-conductor antifuse of Zhang '302. Further, Zhang '396 discloses embodiments in FIGS. 10a and 10b that include quasi-conduction layer 502cb, buffer layer 502cc (formed of tungsten, a low-thermal resistance layer), and antifuse 502ca between conductors 501 and 503. None of these embodiments shows a simple silicon nitride layer between high thermal resistance metal layers 14 and 22 as in Fig. 1 of Zhang '302. Accordingly, there is no reasonable basis for asserting that Zhang '396 and '302 both include metal-to-metal antifuses, or use generally similar materials and similar structures.

Further, as previously stated, specific dissimilarities between Zhang '396 and '302 undermine the adequacy of an alleged motivation or suggestion to combine the references. One of the dissimilarities deals with different forms of electronic memory addressed in the references. In response, the Examiner's Answer at 9-10 states:

It is noted that despite the Appellant's argument that figures 5a-6e in Zhang '396 teach an MPROM embodiment that does not include an antifuse, Zhang '396 specifically identifies quasi-conduction layer '502 as a thin amorphous silicon layer or ceramic oxide layer ... and later states that thin amorphous silicon layers or ceramic oxide layers function as antifuses.

Appellants respectfully submit that the Examiner's assertion regarding the nature and use of quasi-conduction layer '502 is incorrect. Appellants note that FIGS. 6b-6e, identified by the Examiner, refer to MPROM (Zhang '369, col. 2, lines 63-64).

Appellants note that MPROM refers to "mask-programmed read-only memory." MPROM is a well-known term of art, though the term "mask ROM" or MROM" may be more widely used. A exemplary definition of MPROM, or mask-programmed read-only memory, appears at www.wikipedia.com, and is presented below:

One of the earliest forms of non-volatile read-only memory, the mask-programmed ROM was prewired at the design stage to contain specific data; once the mask was used to manufacture the integrated circuits, the data was cast in stone (or at least in silicon) and could not be changed. Whatever 1's and 0's were in memory when it left the factory were there for life.

Indeed, a similar description of the distinction between two types of ROM appears in Zhang '396 at col. 1, lines 23-28:

ROM can be categorized into two classes: mask programmable ROM (MPROM), and electrically programmable ROM (EPROM). In MPROM, digital information is defined by masks during manufacturing, while in EPROM, information can be configured by end users.

Thus, the memory state of MPROM is programmed during fabrication and cannot be changed by the end user. This nature is in contrast to that of field-programmable memory such

as EPROM, in which all memory cells are fabricated unprogrammed, and individual cells in the memory are programmed by the end user.

This distinction is significant, because the purpose of the antifuse in the EPROM embodiments of Zhang '396 is to store the memory state of the cell. When the antifuse is in its original, unprogrammed state, the value of the cell is, for example, a '0.' After the antifuse is ruptured during programming of the cell by the user, the value of the cell is, for example, a '1.'

In MPROM, however, no such change takes place. Each memory cell is fabricated as a '0,' or a '1,' and never changes state. Because there is no change in memory state in any memory cell in an MPROM array, logically there cannot be any element in a MPROM cell behaving as an antifuse, no matter what materials are used to form it. A layer such as the Examiner describes may exist in this cell, but because it is an MPROM cell, clearly there can be no intention to rupture this layer. Thus, any teaching on how to form a memory cell in an MPROM array will have little relevance, if any, to one skilled in the art selecting material to use for an antifuse.

Appellants respectfully submit that, contrary to the Examiner's assertion, Zhang '396 and '302 do not both include metal-to-metal antifuses, and do not use generally similar materials and similar structures. As a result, there is no reasonable basis for concluding that a person of ordinary skill in the art would be motivated to modify the amorphous silicon antifuse layer of Zhang '396 using the silicon nitride antifuse of Zhang '302.

B. Rejection of Claims 1 and 2 Based on Zhang '396 and Mohsen

The Examiner's Answer at 6 asserts that it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the antifuse of Zhang '396 such that it is formed of silicon nitride, as taught by Mohsen because:

A person having ordinary skill in the art would have been motivated to use silicon nitride as the antifuse, because Mohsen shows that silicon nitride is an appropriate antifuse for use between metal electrodes or metal and semiconductor electrodes (Mohsen, column 4, lines 4-10), and that silicon nitride used as an antifuse has the advantageous properties of high reliability in the programmed and unprogrammed state, controllable antifuse

rupturing properties, and high conductivity after programming (see Mohsen, column 2, lines 29-40).

Contrary to the Examiner's assertion, Mohsen does not show that any of the advantages mentioned by the Examiner result from use of silicon nitride as the antifuse. In contrast, Mohsen describes the stated advantages as arising from the overall diode structure disclosed by Mohsen. For example, in the Summary of the Invention, Mohsen repeatedly mentions the semiconductor diode aspects of the invention, but makes no mention of the use of silicon nitride. (Mohsen, col. 2, lines 43-64).

In particular, the passage relied upon by the Examiner states:

Advantages associated with the present invention in some or all of its embodiments include a diode interconnect which can be made with standard semiconductor manufacturing techniques, small size, a high reading current after programming, a manufacturing process with a minimal number of steps, and a controlled-radius interconnect filament through the dielectric resulting in a repeatably manufacturable, controlled, low-resistance link after programming. Furthermore, the present invention is characterized by high reliability in both the programmed and unprogrammed state. Other and further advantages of the present invention will appear hereinafter. (Mohsen, col. 2, lines 29-40).

Nowhere does Mohsen associate any particular advantages with the specific use of silicon nitride as the antifuse. Apart from its claims, Mohsen mentions silicon nitride only five times, and in four out of five instances, the silicon nitride is disclosed as part of a silicon dioxide / silicon nitride / silicon dioxide layerstack. (Mohsen, Abstract; col. 4, lines 15-16, 23; col. 8, lines 10, and 23).

Appellants respectfully submit that Examiner's stated rationale for a motivation to combine Mohsen with Zhang '396 is insufficient insofar as Mohsen does not attribute the alleged qualities, benefits and advantages to the use of silicon nitride as an antifuse. Therefore, a person of ordinary skill in the art would not be motivated to replace the silicon dioxide antifuse of Zhang '396 with the silicon nitride antifuse of Mohsen.

The Examiner 's Answer at 12 also states Mohsen provides motivation for using a silicon nitride structure by citing "low programming currents and higher operational speeds."

Appellants respectfully submit, however, that a person skilled in the art selects an antifuse material based on the requirements of the device, ease of fabrication, etc. Whether silicon nitride is an appropriate choice, let alone an obvious one, for Zhang ‘396, Zhang ‘302 or Mohsen, must be reconsidered anew, as each involves a different device with different requirements.

As Appellants have explained, the contexts are very different for the devices of Zhang ‘396, Zhang ‘302, and Mohsen. The advantages of a silicon nitride antifuse proposed by the Examiner do not appear relevant to the device of Zhang ‘396, and may come with disadvantages. The device of Zhang ‘396 appears to be a low-speed device in which increased rupture speed will bring little or no advantage, and the selection of silicon nitride would make it more difficult to distinguish a programmed cell from an unprogrammed cell, where maximizing this difference is crucial in the large memory array of Zhang ‘396.

Appellants note that silicon nitride antifuses are not universally used even now. The fact that silicon nitride may be an advantageous choice for an antifuse material in one situation does not make it an advantageous choice in another very different situation. If the advantages advanced by the Examiner meant that silicon nitride was, simply, a better antifuse material than, for example, silicon dioxide, regardless of the device, it presumably would be used universally in all devices. This is not the case, however, because the purpose and operation of the device must be considered as well, and different materials would be selected or rejected by one skilled in the art depending on the context. That context is central to the choice, and must be considered.

The question to be answered, then, is not whether silicon nitride antifuses are universally used, which clearly they are not, but whether one skilled in the art, based on the references and on his or her general knowledge, would be motivated to make the Examiner’s suggested combinations. Appellants have explained that the suggested combination would bring no advantage, inasmuch as Zhang ‘396 is a low-speed device, and would introduce the disadvantage that a programmed cell would be more difficult to distinguish from an unprogrammed cell. Thus, Appellants maintain that one skilled in the art would not be motivated to make the suggested combinations.

CONCLUSION

For the reasons set forth above, Appellants respectfully submit that Claim 1 is patentable over the proposed combination of Zhang '396 and Zhang '302, and that Claims 1 and 2 are patentable over the proposed combination of Zhang '396 and Mohsen et al. Accordingly, Appellants respectfully request that the Board reverse the 35 U.S.C. § 103(a) rejections of Claims 1 and 2.

Respectfully Submitted,

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